

JAMES R. KNIGHT

knightjr@ah.org

James is currently the supervisor of clinical engineering at Sonora Regional Medical Center. He is the chairman of the CMIA Training & Education Committee. He also develops biomedical technology training curriculums for both colleges and employers. He was certified by the I.C.C. as a CBET in August 21, 1997. He has worked on biomedical instrumentation since 1985. He is factory trained on nuclear cameras, general radiology & fluoroscopy and cardiac assist equipment used in heart transplants.

Fetal Monitoring

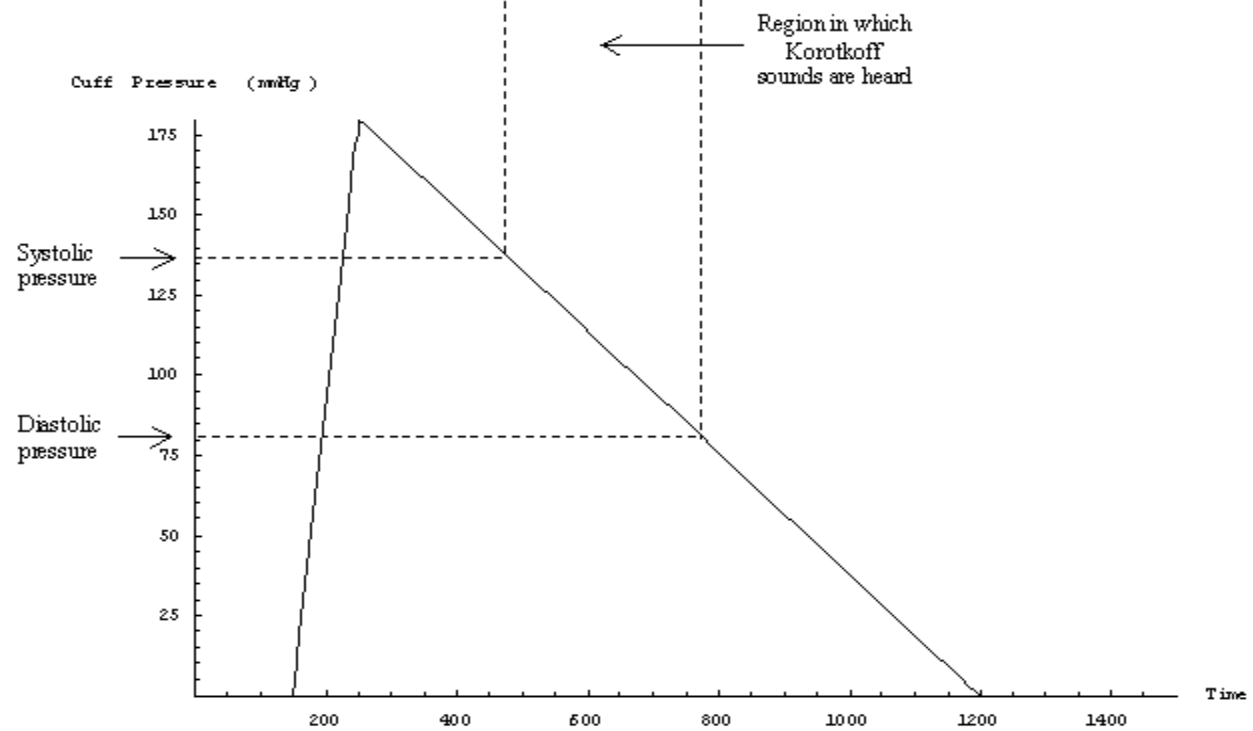
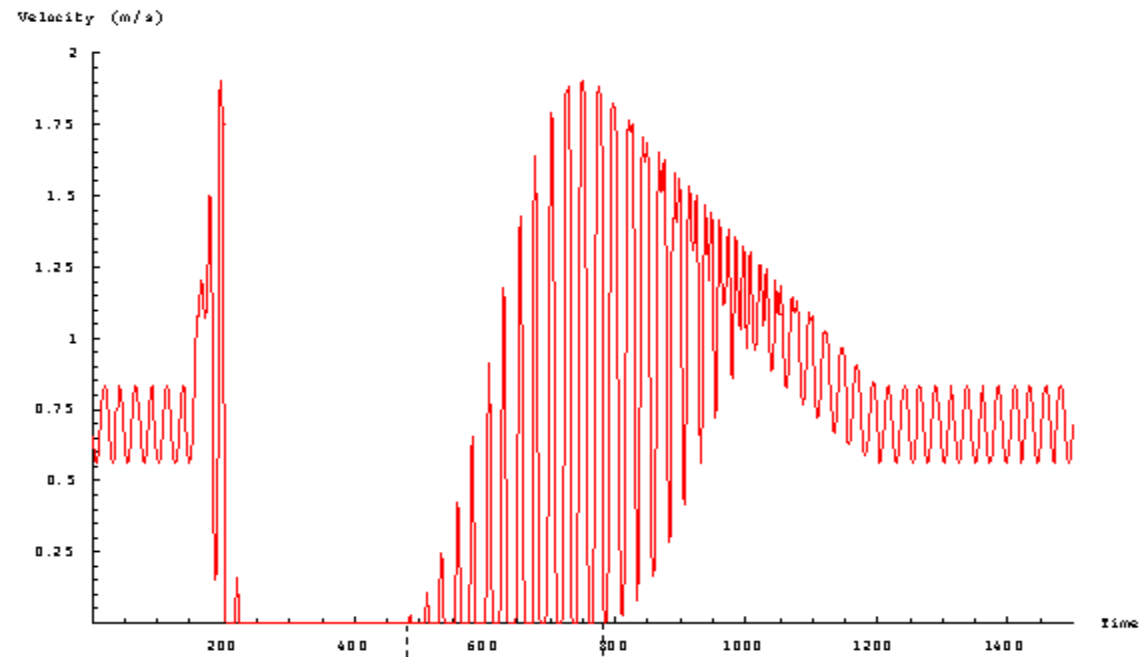
- Monitors both mother and soon to be born child
- Maternal monitoring:
 1. NIBP trending
 2. SpO2 trending
 3. Intra-uterine pressure (external or internal) relative
 4. Electrocardiogram (ECG) actual
- Fetal monitoring:
 1. Ultrasound heart rate actual
 2. Scalp electrode heart rate actual

Heart beat create pressure waves

- The human heart serves as a pump pushing blood through the arteries with each heart beat which produces **pressure pulses**. Pressure pulses then move away from the heart through the arterial system of the body in the form of a **pressure wave**, which changes as it moves further away from the heart. These pressure waves create arterial **pulsations** that can be detected in multiple locations on the human body. Arterial blood pressure is measurement of these pulsations caused by the pressure waves generated by the heart pushing blood through the arteries.

Non-Invasive Blood Pressure

- Inflates cuff placed over brachial artery to preset pressure, usually 160 to 180 mm of Hg
- Detects systole: first pulses (SP), diastole: last pulse (DP) and calculates the mean:
 - Approximately $DP + \frac{1}{3} (SP - DP)$
 - Actually $(CO \times SVR) + CVP$
- NIBP is not actual blood pressure, used only for trending
- Two methods are used :
 - Auscultatory uses a microphone at brachial artery
 - Oscillometric detects SP and DP by oscillations in pressure



SpO2 trending

- Measures the number of oxyhemoglobin molecules carrying oxygen at peripheral site, usually the middle finger.
- Approximates the invasive, painful and slow method of arterial blood sampling.
- Usually 96 to 99% reading, also detects heart rate.
- Sensor has two emitting led's (red & IR) and one photodiode detector.

How to detect oxygen:

- Hemoglobin with oxygen attached is red.
- Hemoglobin without oxygen is blue.
- Arterial blood has higher pulse pressure than venous blood.
- By measuring the quantity of red in the arterial blood we can estimate how much of the arterial hemoglobin is oxygenated (SpO2 : percent O2 saturation)
- Pulsing two frequencies of light (red and infrared) from the sensor and measuring how much light is reflected back (not absorbed by the body) will yield the "R" value.

R value

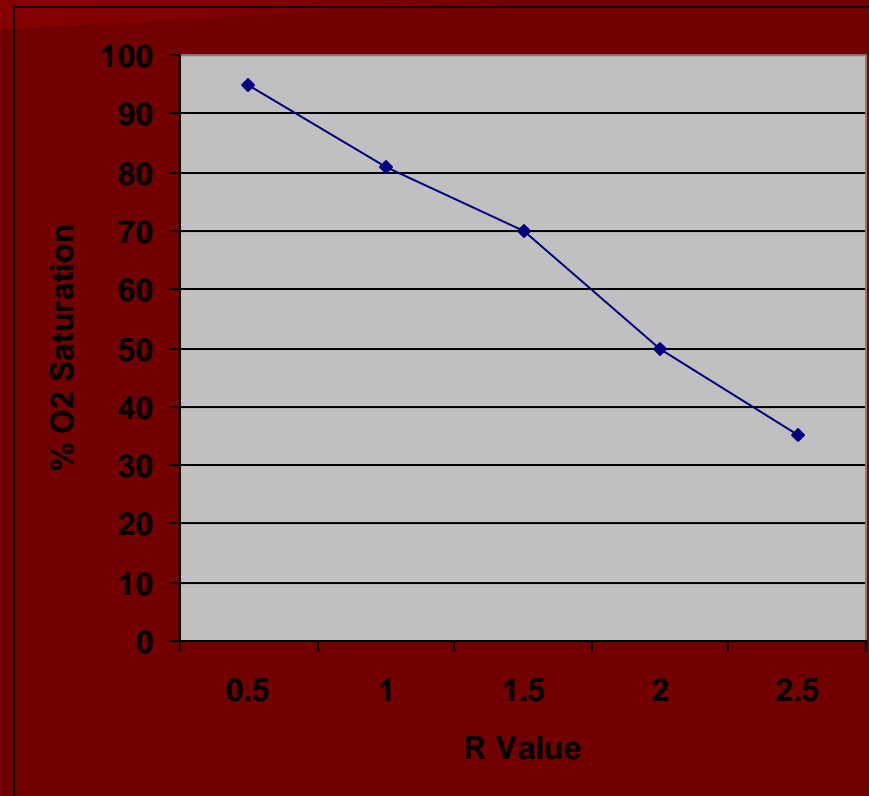
Red SP / Red DP

IR SP / IR DP

Yields R

- All values are actually integrals, areas under the curve, x being millivolts and y being milliseconds
- SP is an ac signal since it is pulsing
- DP is dc value since it is resting

R curve



Brands of SpO₂ monitors

- Nellcor
 - Massimo
 - Nonin
 - Philips
- Nellcor uses four phase sequence:
 1. 184.5 usec IR on
 2. 184.5 usec both off
 3. 184.5 usec red on
 4. 184.5 usec both off

Uterine monitoring

- Relative pressure within the uterus is measured using a tocotransducer attached with a belt to the mother's abdomen in the area of the uterine fundus. The readings are plotted on strip chart recorder on a relative scale from 0 to 100. The resulting graph shows contractions. As the contractions increase in size and lessen in time apart, the clinician is made aware of the pending delivery.

Uterine monitoring can be accomplished two ways

- Externally through a tocotransducer that measures relative pressure changes of the uterine wall
- Internally via a transcervical catheter.

ECG monitoring

- Accomplished with 3 leads, Left & right arms and either left or right leg electrodes. Ag / AgCl electrodes sense a voltage potential difference that is created by K and Na ions traveling in & out of cardiac cell walls. There is no current flow, it is actually action potential.

Ultrasound Monitoring

- Used to detect both maternal and fetal heart rate (actual).
- Uses pulsed Doppler probe to hear an echo of the heart pumping
- Usually a gel is placed between probe and mother to increase gain, reduce noise.
- Most common failure is the probe on a fetal monitor.

Doppler Probe measures heart rate

- Operating Frequency 1-15MHz

■	<u>Material</u>	<u>Velocity (Meter/Sec)</u>
■	Air	330
■	Water	1480
■	Tissue	1540
■	Piezoelectricity (Pressure Electricity)	
■	Piezoelectric crystal-converts one form of energy to another	
■	Does not transmit through air or bone	
■	Conductive gel between probe and patient for better conduction	
■	Corometrics uses 1.151 MHz pulsed carrier signal with a 4 kHz pulsed repetition frequency. The total wave form lasts 250 microseconds with 4 parts: 90usec tx Doppler pulse, 40 usec wait, 90 usec receive reflected signals, 30 usec idle state.	